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Cooling in electric motors

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(56) Documents cited
EP 0125834 A2
EP 0030725 A2
US 4464594 A
US 3558943 A

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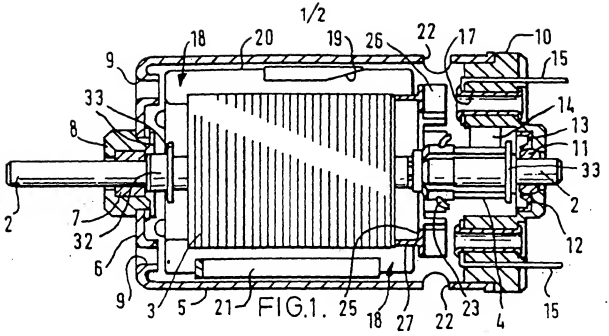


FIG.1.

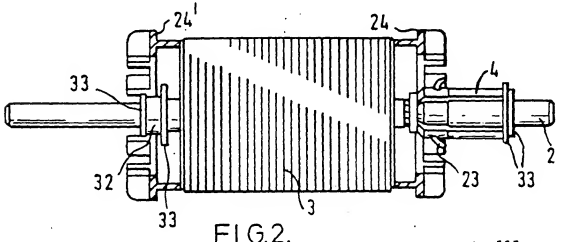
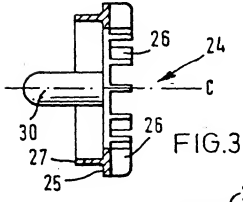


FIG.2.



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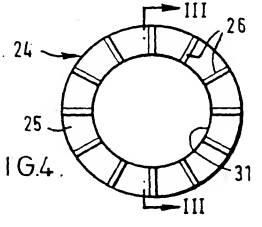
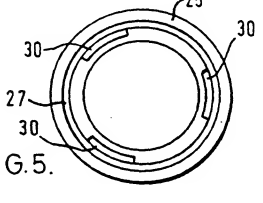


FIG.4.



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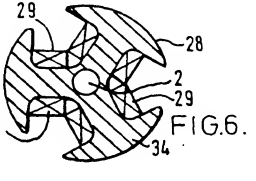

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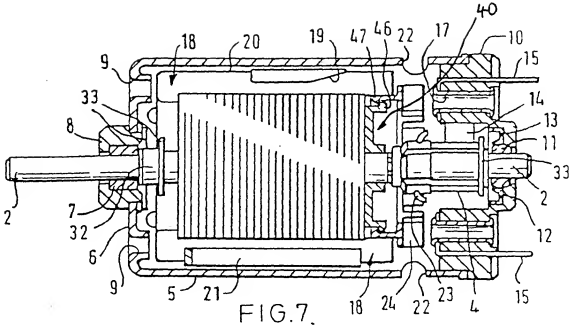

FIG.7.

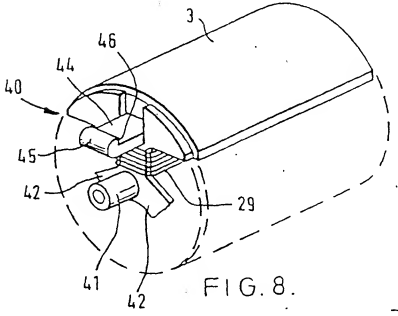

FIG.8.

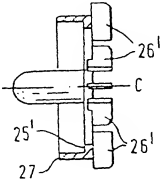

FIG.9.

Cooling in electric motors

The present invention relates to permanent magnet direct current electric motors and in particular to cooling of fractional horsepower p.m.d.c. motors.

There is a constant demand to increase the motor power output of small motors for a given motor size. When such small motors are required to deliver large output powers there is a difficulty in dissipating the heat generated inside the motor through power losses. These motors have small masses and so can experience very rapid rises in temperature in critical areas. At excessive temperatures, various components are subject to damage.

It is known to incorporate a forced ventilation fan within the motor, mounted on the motor shaft, but heretofore this has required an increase in at least the length of the motor which defeats the objective of increasing the power for a given motor size.

It is also known to provide enlarged terminal sections in a commutator, which effectively act as fan blades of a centrifugal fan. Such a commutator is illustrated in U.S. Patent Application No. 837301 filed on 7th March

1986 as a continuation of our Application No. 690761, itself a continuation of No. 526152. However in many applications it is difficult to provide such an enlarged commutator since it might, for example, interfere with the winding areas on the armature.

According to the invention there is provided a permanent magnet direct current electric motor comprising a can-like motor casing, permanent magnet means mounted in the casing, a wound armature and a commutator on a motor shaft mounted for rotation in the motor casing, an end cap closing the motor casing and supporting brush gear of which brushes proper contact with the commutator, a centrifugal fan mounted about the motor shaft between the armature and the brushes, and windows in the motor casing between the armature and the brushes, the fan comprising a plurality of fan blades integral with an annular blade support, defining an eye of the fan, the support being secured to the end of the armature proximate the commutator and at a position adjacent to the outer peripheral surface of the armature whereby air may be drawn into the eye from both axial sides so as to cool the commutator and the wound armature.

With such a fan air can be drawn into the 'eye' of the fan over both the commutator and the armature, both of which are subjected to large temperature rises since losses occur due to electrical heating and friction,

and expelled through the windows in the motor casing. Moreover, the position of the blade support does not detract from the flow of air over the commutator.

The fan is preferably placed around the section of the commutator where winding wires of the armature coils are attached to the commutator. This area is normally provided to allow for commutator tangs to be located near the wound coils. Once the wire connections to the commutator tangs have been made the area has no further purpose. By making use of this unused area for the fan, there is no need to lengthen the motor.

Preferably, the blades extend radially outwards beyond the outer peripheral surface of the armature.

Preferably, the annular blade support comprises a cylindrical wall and an annular blade reinforcing plate extending radially from the end of the wall remote from the armature. In this case the reinforcing plate may extend between the radially innermost and radially outermost edges of the blades. However, advantageously, the blades extend radially beyond the blade support.

Preferably, the fan is glued to the armature.

Alternatively, however, the fan may be snap-fittably engaged with a fan mounting member connected to the armature, e.g. by coils of the armature wound around arms of the armature and correspondingly shaped arms of the fan mounting member.

Where the armature comprises a plurality of radially extending arms having coils wound thereon, the fan may be provided with at least one tab, the or each tab extending between an adjacent pair of arms and coils.

Other advantages and preferred features of the invention will be apparent from the accompanying claims and following description.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a side cross-sectional view of a permanent magnet direct current small electric motor embodying the invention;

Figure 2 shows a modification of the rotor of the motor of Figure 1;

Figure 3 is a cross-sectional view of a fan of the motor of Figures 1 and 2, along the line III-III of Figure 4;

Figure 4 is a front view of the fan of Figure 3;

Figure 5 is a rear view of the fan of Figure 3;

Figure 6 is a transverse cross-sectional through the armature of Figure 1;

Figure 7 is a view similar to Figure 1 and showing an alternative way of mounting the fan;

Figure 8 is a perspective view showing part of the armature and fan mounting member of the motor of Figure 7; and

Figure 9 is a view similar to Figure 3 and showing an alternative fan.

Referring to Figure 1, a small, fractional horsepower permanent magnet direct current motor 1 is illustrated. The motor comprises a motor shaft 2 which carries a wound armature 3 and commutator 4. The

commutator 4 and armature 3 are mounted fast on the shaft and the armature is wound and connected to the commutator in the manner generally known in the art.

The shaft 2 is mounted in a cylindrical can-like metal casing 5. Casing 5 is closed at one end 6 by an integrally formed end plate. End plate 6 carries a bearing 7 in a housing 8, the shaft 2 being journalled in the bearing 7. A brass collar 32 is a force fit on the shaft 2 to limit the axial movement of the shaft through the bearing 7.

End plate 6 has a plurality, typically 4, of circumferentially extending slots 9 for ventilation of the inside of the motor.

A plastics end cap 10, typically of nylon, houses a self aligning sintered bearing 11 which is held in place by axially extending tabs 12 of a washer 13 which is pressed into the end cap. The end cap supports brush gear comprising a pair of carbon brushes 14 (one is seen in Figure 1) which are urged against the commutator 4 by brush leaves (not seen in Figure 1) connected to power supply tags 15.

Washers 33 may be provided to adjust the axial position

of the armature relative to the permanent magnets and provide bearing surfaces in the axial direction.

Apertures (not shown) are formed in the end cap 10 allowing further ventilation of the inside of the motor.

The casing 5 carries two permanent magnets 18, which each bear at one axial edge 20 against a respective tang 19 and are urged apart at their other axial edges by a 'U' shape spring 21.

Windows in the form of circumferentially extending slots 22 are provided in the casing 5 in the region between the brushes 14 and armature 3.

The construction thus for described is well known in the art and embodied in a small p.m.d.c. motor manufactured and sold by the applicants under catalogue No. HC613.

The improvement provided by the present invention in the construction of Figure 1, is the disposition of a fan 24 between the brushes 14 and the armature 3, about the region of commutator tangs 23 which are used to electrically connect wires of the coils in armature 3 to the commutator 4.

The fan 24 is illustrated in Figures 3 and 4 and is of centrifugal type, comprising a plurality of radially extending blades 26 integral with an annular blade support, which in the example shown comprises a cylindrical wall 27 which rests against the armature 3 and an annular blade reinforcing plate 25 extending radially from the end of the wall 27 remote from the armature 3. Indeed in the example shown in Figures 3 and 4 the plate 25 extends over the entire radial extent of the blades 26 and supports the latter.

The armature 3 is illustrated in cross-section in Figure 6 and comprises a central core 34 mounted fast on shaft 2 with three (in this example) mushroom cross-section extensions 28 extending radially out from the core.

The extensions 28 extend in the axial direction of the shaft 2 and coils 29 are wound around the stems of the mushrooms 28.

Fan 24 has three tabs 30 spaced at 120 degrees around the centre line C of the fan and extending rearwardly from the plate 25. Each tab 30 is arranged to project between a pair of mushrooms 28, 29 to mount the

fan 24 on the end of the armature. The cylindrical wall 27 and/or the tabs 30 is glued to the armature with epoxy resin.

The annular plate 25 has a large centre eye 31 so as to expose the axial ends of the coils 29.

The fan 24 is integrally formed of nylon or other suitable plastics material by moulding.

As the motor is run, shaft 2 rotates with armature 3 and commutator 4. The fan blades 26, which are opposite slots 22 in the casing 5, force air radially outwardly through the slots 22. Air is drawn into the eye 31 inside of the blades 26. The air is thus drawn over the commutator 4 and the coils 29, to cool the armature and the commutator.

Figure 2 shows a modification of the motor of Figure 1, and shows the shaft 2 with armature 3 and commutator 4 thereon. In addition to fan 24 a second fan 24' of the same construction is mounted at the other end of armature 3. The position of the fan 24' may require the casing 5 to be lengthened to accommodate the fan 24' with repositioning of spacer 32 if necessary.

To assemble the rotor of the motor the armature 3 and commutator 4 are fitted on the shaft 2 and the armature coils wound and connected to the commutator in a manner known per se.

The eye 31 of fan 24 may then be passed over the commutator 4 and the tabs 30 inserted between the coils 29. The fan 24 is then glued to the armature.

Fan 24', if provided in addition to fan 24, is simply passed over the end of the shaft 2 and fitted as for fan 24. The rotor may then be inserted in the motor casing 5 and the end cap 10 and brush assembly fitted.

Figures 7 and 8 illustrate an alternative way of mounting the fan, which avoids the use of glue. This involves the use of a fan mounting member 40 with which the fan 24 is snap-fittably engaged. The mounting member 40, which is conveniently of plastics material, generally takes the shape of one of the armature laminations and comprises a central sleeve 41 push fitted on the shaft 2 and three mushroom shaped arms 42 extending from the sleeve 41 in equi-angularly spaced relationship. The member 40 is secured firmly to the armature by coils 29 which are wound around the arms 42 as well as around the arms of the armature. A

resilient finger 44 extends in an axial direction from the head of each mushroom shaped arm 42 away from the armature 3 and has a radially outwardly enlarged head 45 to define a shoulder 46. As will be appreciated from the above the member 40 is mounted on the shaft 2 against an end face of the armature prior to winding the armature coils.

The cylindrical wall 27 of the fan has three equi-angularly spaced radially inwardly directed projections 47 which snap-fittably engage behind the shoulders 46 when the fan 24 is pushed over the fingers 44 in an axial direction. The tabs 30 are retained and these project between the mushroom-shaped extensions of the armature to locate the fan 24 angularly in relation to the armature 3 and to ensure that the projections 47 align with the shoulders 46 as the fan 24 is fitted on the member 40.

The fan in Figure 9 differs from that shown in Figures 1 to 6, in that the blade reinforcing plate 25' is of reduced size and lies within the radial confines of the cylindrical wall 27 of the fan and in that most of the fan blades 26' are extended both radially inwards and radially outwards as compared with the blades 26. However, those blades which are radially aligned with

the commutator tangs 23 may terminate at their radially innermost edge in alignment with the inner edge of the blade reinforcing plate 25' so as not to hinder air flow through the passages between adjacent mushrooms 28. A fan as shown in Figure 9 has been found to provide improved cooling of the motor and this is believed to be due in part to the larger fan blades creating a larger air flow and in part to the smaller blade reinforcing plate which provides for a better air flow over the armature.

Further modifications will be apparent to those skilled in the art and it is desired to include all such modifications as fall within the scope of the invention.

CLAIMS

1. A permanent magnet direct current electric motor comprising a can-like motor casing, permanent magnet means mounted in the casing, a wound armature and a commutator on a motor shaft mounted for rotation in the motor casing, an end cap closing the motor casing and supporting brush gear of which brushes proper contact with the commutator, a centrifugal fan mounted about the motor shaft between the armature and the brushes, and windows in the motor casing between the armature and the brushes, the fan comprising a plurality of fan blades integral with an annular blade support defining an eye of the fan, the support being secured to the end of the armature proximate the commutator and at a position adjacent to the outer peripheral surface of the armature, whereby air may be drawn into the eye from both axial sides so as to cool the commutator and the wound armature.

2. An electric motor as claimed in claim 1, wherein the blades extend radially outwards beyond the outer peripheral surface of the armature.

3. An electric motor as claimed in claim 1 or claim 2, wherein the annular blade support comprises a cylindrical wall and an annular blade reinforcing plate extending radially from the end of the wall

remote from the armature.

4. An electric motor as claimed in claim 3, wherein the reinforcing plate extends over or substantially over the entire radial extent of the blades.

5. An electric motor as claimed in claim 3, wherein the blades extend radially beyond the blade support.

6. An electric motor as claimed in anyone of the preceding claims, wherein the armature comprises a plurality of radially extending arms having coils wound thereon, and the fan is provided with at least one tab, the or each tab extending between an adjacent pair of arms and coils.

7. An electric motor as claimed in anyone of the preceding claims, wherein the fan is glued to the armature.

8. An electric motor as claimed in anyone of claims 1 to 5, including a fan mounting member connected to the armature, the fan and the fan mounting member having complementary formations by

which the fan is snap-fittably engaged with the fan mounting member.

9. An electric motor as claimed in claim 8, wherein the fan mounting member has a shape corresponding substantially to the cross-sectional shape of the armature, the fan mounting member being connected to the end of the armature proximate the commutator by coils of the armature.

10. An electric motor as claimed in anyone of the preceding claims, wherein the commutator comprises a plurality of circumferentially spaced tangs which are electrically connected to coils of the armature, and the fan is mounted about the tangs.

11. An electric motor as claimed in anyone of the preceding claims, wherein a further fan is provided on the end of the armature distal of the commutator.

12. A permanent magnetic direct current electric motor substantially as hereinbefore described with reference to the accompanying drawings.